CLAIMS

What is claimed is:

1. An apparatus, comprising;

a wave guide switching element, comprising:

a wave guide substrate;

at least one planar wave guide attached to the wave guide substrate;

a liquid crystal material attached to the a wave guide substrate, the liquid crystal material in operative optical contact with the at least one planar wave guide, the liquid crystal material having a first and second state, wherein the index of refraction of the liquid crystal material in the first state matches the index of refraction of the at least one planar wave guide, and wherein the index of refraction of the liquid crystal material in the second state does not match the index of refraction of the at least one planar wave guide;

a means for applying an electric field across the liquid crystal material, wherein the liquid crystal material switches between the first state and the second state as the electric field is applied ;

wherein a beam of light in any polarization propagating in the wave guide is not reflected when the beam of light in any polarization reaches the liquid crystal material in the first state, and wherein the beam of light in any polarization is reflected when the liquid crystal material is in the second state.

2. The wave guide switching element according to Claim 1 wherein the first state of the liquid crystal is an isotropic state and the second state of the liquid crystal is a nematic state.

3. The wave guide switching element according to Claim 2 wherein the nematic state of the liquid crystal is a field-forced nematic state.

4. The wave guide switching element according to Claim 1 wherein the first state of the liquid crystal is a nematic state and the second state of the liquid crystal is a nematic state.

5. The wave guide switching element according to Claim 1 wherein the liquid crystal material is contained inside a trench.

6. The wave guide switching element according to Claim 5 wherein the trench intersects the at least one planar wave guide.

7. The wave guide switching element according to Claim 5 wherein the trench intersects at least one planar wave guide at an angle greater than the critical angle for total internal reflection when the liquid crystal material is in the second state.

8. The wave guide switching element according to Claim 1 wherein the means for applying an electric field across the liquid crystal material is a pair of electrodes.

9 The wave guide switching element according to Claim 8 wherein the pair of electrodes is in electric connection with the liquid crystal material.

10. The wave guide switching element according to Claim 8 wherein the pair of electrodes is made from Indium-Tin-Oxide.

11. The wave guide switching element according to Claim 8 wherein the pair of electrodes is in-plane switching electrodes, the pair of the in-plane switching electrodes switches the liquid crystal material in plane.

12. The wave guide switching element according to Claim 11 wherein the in-plane switching electrodes are at the top of the liquid crystal.

13. The wave guide switching element according to Claim 1 further comprising;

a cover substrate.

14. The wave guide switching element according to Claim 13 wherein the cover substrate has a first and second surface.

15. The wave guide switching element according to Claim 14 wherein the first surface of the cover substrate contacts the wave guide surface of the wave guide substrate.

16. The wave guide switching element according to Claim 15 wherein the first surface of the cover substrate contains a pair of in-plane switching electrodes.

17. The wave guide switching element according to Claim 1, further comprising;

an alignment layer, the alignment layer contacting the liquid crystal material.

18. The wave guide switching element according to Claim 17 wherein the alignment layer is for homogeneous alignment of the liquid crystal material.

19 The wave guide switching element according to Claim 17, wherein the alignment layer is for homeotropic alignment of the liquid crystal material.

20. The wave guide switching element according to Claim 1 wherein the beam of light is linearly polarized.

21. The wave guide switching element according to Claim 1 wherein the beam of light is circularly polarized.

22. The wave guide switching element according to Claim 1 wherein the beam of light. is randomly polarized.

23. The wave guide switching element according to Claim 1 wherein the beam of light is reflected via total internal reflection when the liquid crystal material is in the second state.

24. A method for producing a wave guide switching element, comprising;

a) providing a wave guide substrate;

b) attaching at least one planar wave guide to the wave guide substrate;

c) attaching a liquid crystal material to the wave guide substrate, the liquid crystal material in operative optical contact with the at least one planar wave guide, the liquid crystal material having a first and second state, wherein the index of refraction of the liquid crystal material in the first state matches the index of refraction of the at least one planar wave guide, and wherein the index of refraction of the liquid crystal material in the second state does not match the index of refraction of the at least one planar wave guide; and

d) providing a means for applying an electric field across the liquid crystal material, wherein the liquid crystal material switches between the first state and the second state as the electric field is applied,

wherein a beam of light in any polarization propagating in the wave guide is not reflected when the beam of light in any polarization reaches the liquid crystal material in the first state, and wherein the beam of light in any polarization is reflected when the liquid crystal material is in the second state.

25. The method of Claim 24 wherein step b) comprises;

providing the at least one planar wave guide with a curvature path for propagation of the beam of light.

26. The method of Claim 25 wherein the step of providing the at least one planar wave guide comprises;

providing the at least one planar wave guide with a curvature path for propagation of the beam of light in linear polarization.

27. The method of Claim 25 wherein the step of providing the at least one planar wave guide comprises;

providing the at least one planar wave guide with a curvature path for propagation of the beam of light in circular polarization.

28. The method of Claim 25 wherein the step of providing the at least one planar wave guide comprises;

providing the at least one planar wave guide with a curvature path for propagation of the beam of light in random polarization.

29. The method of claim 24, further comprising;

e) bonding a cover substrate having opposed first and second surfaces to the wave guide surface of the wave guide substrate, the first surface of the cover substrate contacting the wave guide surface of the wave guide substrate.

30. The method of claim 29, wherein step e) further comprises;

providing a pair of electrodes on the first surface of the cover substrate contacting the wave guide surface of the wave guide substrate.

31. The method of Claim 30, wherein the pair of electrodes is in-plane switching electrodes, the pair of in-plane switching electrodes switching the liquid crystal material in plane.

32. The method of claim 29, wherein step e) further comprises;

providing an alignment layer on the first surface of the cover substrate contacting the wave guide surface of the wave guide substrate.

33. The method of claim 24, wherein step c) comprises;

c1) providing a trench in the wave guide substrate, wherein the trench cuts the planar wave guide; then

c2) filling the trench with a liquid crystal material.

34. The method of claim 33, wherein step c1) further comprises;

providing the trench, wherein the trench intersects the at least one planar wave guide at an angle greater than the critical angle for total internal reflection, wherein the beam of light is reflected via total internal reflection when the liquid crystal material is in the second state.

35. The method of claim 33, wherein step c1) further comprises;

providing an alignment layer on walls of the trench.

36. The method of claim 33, wherein step c1) further comprises;

providing electrodes on walls of the trench.

37. The method of claim 24, wherein step d) comprises;

providing a pair of electrodes, wherein the pair of electrodes is in electrical connection with the liquid crystal material.

38. The method of Claim 37, wherein the pair of electrodes is in-plane switching electrodes, the pair of in-plane switching electrodes switching the liquid crystal material in plane.

39. The method of Claim 24, further comprising

f) providing an alignment layer on the waveguide substrate, the alignment layer in direct contact with the liquid crystal material.

40. An apparatus, comprising;

a wave guide beam steering device comprising a plurality of wave guide switching elements, comprising;

a wave guide substrate;

a plurality of planar wave guides attached to the wave guide substrate;

a plurality of liquid crystal materials attached to the wave guide substrate, the plurality of liquid crystal materials in operative optical contact with the plurality of planar wave guides, the plurality of liquid crystal materials having a first and second state, wherein the index of refraction of the plurality of liquid crystal materials in the first state matches the index of refraction of the plurality of planar wave guides, and wherein the index of refraction of the plurality of liquid crystal materials in the second state does not match the index of refraction of the plurality of planar wave guides;

a means for applying an electric field across the plurality of liquid crystal materials, wherein the plurality of liquid crystal materials switch between the first state and the second state as the electric field is applied;

a plurality of optical elements, the plurality of optical elements for coupling a beam of light of any polarization into and for receiving beam of light of any polarization reflected from each wave guide switching element of the wave guide beam steering device,

wherein a beam of light of any polarization state propagating in the wave guide is not reflected out of the wave guide beam steering device when the beam of light of any polarization state propagating in the wave guide reaches one of the plurality of liquid crystal materials in the first state, and wherein the beam of light of any polarization state is reflected out of the wave guide beam steering device when one of the plurality of liquid crystal materials is in the second state.

41. The wave guide beam steering device according to Claim 40, wherein the first state of the plurality of liquid crystal materials is an isotropic state and the second state of the plurality of liquid crystal materials is a nematic state.

42. The wave guide beam steering device according to Claim 41, wherein the nematic state of the plurality of liquid crystal materials is the field-forced nematic state.

43. The wave guide beam steering device according to Claim 40 wherein the first state of the plurality of liquid crystal materials is a nematic state and the second state of the plurality of liquid crystal materials is a nematic state.

44. The wave guide beam steering device according to Claim 40, wherein the plurality of liquid crystal materials are contained inside a plurality of trenches.

45. The wave guide beam steering device according to Claim 44, wherein the plurality of trenches intersect the plurality of planar wave guide.

46. The wave guide beam steering device according to Claim 45, wherein the plurality of trenches intersect at least one planar wave guide at an angle greater than the critical angle for total internal reflection when the liquid crystal material is in the second state.

47. The wave guide beam steering device according to Claim 40, wherein the means for applying an electric field across the plurality of liquid crystal materials is a plurality of pairs of electrodes.

48. The wave guide beam steering device according to Claim 47, wherein the plurality of pairs of electrodes are in electric connection with the plurality of liquid crystal materials.

49. The wave guide beam steering device according to Claim 48, wherein the plurality of pairs of electrodes are made from Indium-Tin-Oxide.

50. The wave guide beam steering device according to Claim 48, wherein the plurality of pairs of electrodes are in-plane switching electrodes, the plurality of pairs of the in-plane switching electrodes switching the liquid crystal material in plane.

51. The wave guide beam steering device according to Claim 50, wherein the plurality of pairs of in-plane switching electrodes are at the top of the plurality of liquid crystal materials.

52. The wave guide beam steering device according to Claim 48, wherein the plurality of pairs of electrodes are solid electrodes.

53. The wave guide beam steering device according to Claim 40 further comprising a cover substrate.

54.The wave guide beam steering device according to Claim 53, wherein the cover substrate has a first and second surface.

55.The wave guide beam steering device according to Claim 54, wherein the first surface of the cover substrate contacts the wave guide surface of the wave guide substrate.

56.The wave guide beam steering device according to Claim 55, wherein the first surface of the cover substrate contains a plurality of pairs of in-plane switching electrodes.

57. The wave guide beam steering device according to Claim 40 further comprising;

an alignment layer contacting the plurality of liquid crystal materials.

58. The wave guide beam steering device according to Claim 57 wherein the alignment layer is for homogeneous alignment of the plurality of liquid crystal materials.

59. The wave guide beam steering device according to Claim 57 wherein the alignment layer is for homeotropic alignment of the plurality of liquid crystal materials.

60. The wave guide beam steering device according to Claim 40 wherein the beam of light is linearly polarized.

61. The wave guide beam steering device according to Claim 40 wherein the beam of light is circularly polarized.

62. The wave guide beam steering device according to Claim 40 wherein the beam of light is randomly polarized.

63. The wave guide beam steering device according to Claim 40 wherein the beam of light is reflected via total internal reflection when one of the plurality of liquid crystal materials is in the second state.

64. The wave guide beam steering device according to Claim 40 wherein at least one of the plurality of planar wave guides has a curvature path for propagation of the beam of light in any polarization.

65.The wave guide beam steering device according to Claim 40 wherein the plurality of optical elements are Grinlenses.

66. The wave guide beam steering device in Claim 40 further comprising;

at least one receiver, the at least one receiver for receiving an optical signal.

67. The wave guide beam steering device in Claim 66 wherein the at least one receiver is a focal plane array.

68. The wave guide beam steering device in Claim 67 wherein the focal plane array is a quadrant focal plane array.

69. A method for producing a wave guide beam steering device, comprising;

a) providing a wave guide substrate;

b) attaching a plurality of planar wave guides to the wave guide substrate;

c) attaching a plurality of liquid crystal materials to the wave guide substrate, the liquid crystal material in operative optical contact with the plurality of planar wave guides , the liquid crystal material having a first and second state, wherein the index of refraction of the liquid crystal material in the first state matches the index of refraction of the plurality of planar wave guides, and wherein the index of refraction of the liquid crystal material in the second state does not match the index of refraction of the plurality of planar wave guides;

d) providing a means for applying an electric field across the plurality of liquid crystal materials, wherein the plurality of liquid crystal materials switch between the first state and the second state as the electric field is applied, and

e) attaching a plurality of optical elements,

wherein a beam of light in any polarization propagating in the wave guide is not reflected out of the wave guide beam steering device when the beam of light reaches one of the plurality of the liquid crystal materials in the first state, and wherein the beam of light is reflected out of the wave guide beam steering device when one of the plurality of the liquid crystal materials is in the second state.

70. The method of Claim 69, wherein step b) comprises;

attaching at least one planar wave guide with a curvature path for propagation of the beam of light .

71. The method of Claim 69 wherein the step of providing the plurality of planar wave guides comprises;

providing the plurality of planar wave guides for propagation of the beam of light in linear polarization.

72. The method of Claim 69 wherein the step of providing the plurality of planar wave guides comprises;

providing the plurality of planar wave guides for propagation of the beam of light in circular polarization. .

73. The method of Claim 69 wherein the step of providing the plurality of planar wave guides comprises;

providing the plurality of planar wave guides for propagation of the beam of light in random polarization..

74. The method of claim 69, further comprising;

f) bonding a cover substrate having opposed first and second surfaces to the wave guide surface of the wave guide substrate, the first surface of the cover substrate contacting the wave guide surface of the wave guide substrate.

75. The method of claim 74, wherein step f) further comprises;

providing a plurality of pairs of electrodes on the first surface of the cover substrate contacting the wave guide surface of the wave guide substrate.

76. The method of Claim 75 wherein the plurality of pairs of electrodes are in-plane switching electrodes, the plurality of pairs of in-plane switching electrodes switching the liquid crystal material in plane.

77. The method of claim 74, wherein step f) further comprises;

providing an alignment layer on the first surface of the cover substrate contacting the wave guide surface of the wave guide substrate.

78. The method of Claim 69, wherein step c) comprises;

c1) providing a plurality of trenches in the wave guide substrate, wherein the plurality of trenches cut the plurality of planar wave guides; then

c2) filling the plurality of trenches with a liquid crystal material.

79. The method of claim 78, wherein step c1) further comprises;

providing the plurality of trenches, wherein the plurality of trenches intersect the at least one planar wave guide at an angle greater than the critical angle for total internal reflection, wherein the beam of light is reflected via total internal reflection when the liquid crystal material is in the second state.

80. The method of claim 78, wherein step c1) further comprises;

providing an alignment layer on walls of the plurality of trenches.

81. The method of claim 78, wherein step c1) further comprises;

providing electrodes on walls of the plurality of trenches.

82. The method of claim 69, wherein step d) comprises;

providing a plurality of pairs of electrodes, wherein the plurality of pairs of electrodes are in electrical connection with the plurality of liquid crystal materials.

83. The method of Claim 82 wherein the plurality of pairs of electrodes are in-plane switching electrodes, the plurality of pairs of in-plane switching electrodes switching the liquid crystal material in plane.

84. The method according to Claim 69, further comprising

g) providing an alignment layer on the waveguide substrate, the alignment layer in direct contact with the liquid crystal material.

85. The method of Claim 69, wherein step e) comprises:

e1) creating a plurality of taps at the end of the plurality of the planar wave guides; then

e2) inserting a plurality of coupling lens elements into the plurality of taps.

86. An apparatus, comprising;

an optical transmitter device, comprising;

at least one wave guide beam steering device comprising a plurality of wave guide switching elements, comprising;

a wave guide substrate;

a plurality of planar wave guides attached to the wave guide substrate;

a plurality of liquid crystal materials attached to the wave guide substrate, the plurality of liquid crystal materials in operative optical contact with the plurality of planar wave guides, the plurality of liquid crystal materials having a first and second state, wherein the index of refraction of the plurality of liquid crystal materials in the first state matches the index of refraction of the plurality of planar wave guides, and wherein the index of refraction of the plurality of liquid crystal materials in the second state does not match the index of refraction of the plurality of planar wave guides;

a means for applying an electric field across the plurality of liquid crystal materials, wherein the plurality of liquid crystal materials switch between the first state and the second state as the electric field is applied;

a plurality of optical elements, the plurality of optical elements for coupling a beam of light of any polarization into and for receiving beam of light of any polarization reflected from each wave guide switching element of the wave guide beam steering device,

wherein a beam of light of any polarization state propagating in the wave guide is not reflected out of the wave guide beam steering device when the beam of light of any polarization state propagating in the wave guide reaches one of the plurality of liquid crystal materials in the first state, and wherein ~~whereby~~ the beam of light of any polarization state is reflected out of the wave guide beam steering device when one of the plurality of liquid crystal materials is in the second state; and

a first plurality of fine beam steering elements for receiving light from the at least one wave guide beam steering device, the first plurality of fine beam steering elements surrounding the at least one wave guide beam steering device,

wherein the optical transmitter device steers at least one beam of light in any polarization over 360° in azimuth.

87. The optical transmitter device according to Claim 86 further comprising;

at least one receiver for receiving optical signal.

88. The optical transmitter device according to Claim 87 wherein the at least one receiver is a focal plane array.

89. The optical transmitter device according to Claim 88 wherein the focal plane array is a quadrant focal plane array.

90. The optical transmitter device according to Claim 86 wherein each of the first plurality of fine beam steering elements is a liquid crystal optical phased array beam steering device.

91. The optical transmitter device according to Claim 86 wherein the at least one beam of light is linearly polarized.

92. The optical transmitter device according to Claim 86 wherein the at least one beam of light is circularly polarized.

93. The optical transmitter device according to Claim 86 wherein the at least one beam of light is randomly polarized.

94. The optical transmitter device in Claim 86 further comprising;

a second plurality of fine beam steering elements for receiving light from the first plurality of fine beam steering elements, wherein the optical axis of each of the second plurality of fine beam steering elements is orthogonal to the optical axis of the corresponding one of the first plurality of fine beam steering elements;

wherein the optical transmitter device steers at least one beam of light in any polarization over 360° in azimuth and at least two angles in elevation.

95. The optical transmitter device in Claim 94 further comprising at least one receiver for receiving optical signal.

96. The optical transmitter device in Claim 95 wherein the at least one receiver is a focal plane array.

97. The optical transmitter device in Claim 96 wherein the focal plane array is a quadrant focal plane array.

98. The optical transmitter device according to Claim 94 wherein each of the second plurality of fine beam steering elements is a liquid crystal optical phased array beam steering device.

99. The optical transmitter device according to Claim 94 wherein the at least one beam of light is linearly polarized.

100. The optical transmitter device according to Claim 94 wherein the at least one beam of light is circularly polarized.

101. The optical transmitter device according to Claim 94 wherein the at least one beam of light is randomly polarized.

102. The optical transmitter device in Claim 86 further comprising;

a first plurality of electrically switchable mirror elements for receiving light from the first plurality of fine beam steering elements, the first plurality of electrically switchable mirror elements surrounding the at least one wave guide beam steering device;

wherein the optical transmitter device steers at least one beam of light in any polarization over 360° in azimuth and at least two angles in elevation.

103. The optical transmitter device in Claim 102 further comprising at least one receiver.

104. The optical transmitter device in Claim 103 wherein the at least one receiver is a focal plane array.

105. The optical transmitter device in Claim 104 wherein the focal plane array is a quadrant focal plane array.

106. The optical transmitter device according to Claim 102. wherein the first plurality of electrically switchable mirror elements are made from cholesteric liquid crystal material.

107. The optical transmitter device according to Claim 106 wherein the first plurality of electrically switchable mirror elements further comprise a quarter wavelength retarder.

108. The optical transmitter device according to Claim 106 wherein the first plurality of electrically switchable mirror elements consist of a left-handed cholesteric liquid crystal material and a right-handed cholesteric liquid crystal material.

109. The optical transmitter device according to Claim 106 wherein the cholesteric liquid crystal material for the first plurality of electrically switchable mirror elements has a constant pitch.

110. The optical transmitter device according to Claim 106 wherein the cholesteric liquid crystal material for the first plurality of electrically switchable mirror elements has a variable pitch. .

111. The optical transmitter device according to Claim 102 wherein the at least one beam of light is linearly polarized.

112. The optical transmitter device according to Claim 102. wherein the at least one beam of light is circularly polarized.

113. The optical transmitter device according to Claim 102 wherein the at least one beam of light is randomly polarized.

114. The optical transmitter device in Claim 94. further comprising;

a first plurality of electrically switchable mirror elements for receiving light from the second plurality of fine beam steering elements;

wherein the optical transmitter device steers at least one beam of light in any polarization over 360° in azimuth and at least two angles in elevation.

115. The optical transmitter device in Claim 114 further comprising at least one receiver

116. The optical transmitter device according to Claim 115 wherein the at least one receiver is a focal plane array

117. The optical transmitter device according to Claim 116 wherein the focal plane array is a quadrant focal plane array

118. The optical transmitter device according to Claim 114 wherein the first plurality of electrically switchable mirror elements are made from cholesteric liquid crystal material.

119. The optical transmitter device according to Claim 118 wherein the first plurality of electrically switchable mirror elements further comprise a quarter wavelength retarder.

120. The optical transmitter device according to Claim 118 wherein the first plurality of electrically switchable mirror elements consist of a left-handed cholesteric liquid crystal material and a right-handed cholesteric liquid crystal material.

121. The optical transmitter device according to Claim 118 wherein the cholesteric liquid crystal material for the first plurality of electrically switchable mirror elements has a constant pitch.

122. The optical transmitter device according to Claim 118 wherein the cholesteric liquid crystal material for the first plurality of electrically switchable mirror elements has a variable pitch. .

123. The optical transmitter device according to Claim 114 wherein the at least one beam of light is linearly polarized.

124. The optical transmitter device according to Claim 114 wherein the at least one beam of light is circularly polarized.

125. The optical transmitter device according to Claim 114 wherein the at least one beam of light is randomly polarized.

126. The optical transmitter device in Claim 102 further comprising;

a second plurality of electrically switchable mirror elements for receiving light from the first plurality of electrically switchable mirror elements, the second plurality of electrically switchable mirror elements joining the first plurality of electrically switchable mirror elements at an angle;

wherein the optical transmitter device steers at least one beam of light in any polarization over 360^{o} in azimuth and at least two angles in elevation.

127. The optical transmitter device in Claim 126 further comprising at least one receiver

128. The optical transmitter device according to Claim 127 wherein the at least one receiver is a focal plane array

129. The optical transmitter device according to Claim 128 wherein the focal plane array is a quadrant focal plane array

130. The optical transmitter device according to Claim 126 wherein the second plurality of electrically switchable mirror elements are made from cholesteric liquid crystal material.

131. The optical transmitter device according to Claim 130 wherein the second plurality of electrically switchable mirror elements further comprise a quarter wavelength retarder.

132. The optical transmitter device according to Claim 130 wherein the second plurality of electrically switchable mirror elements consist of a left-handed cholesteric liquid crystal material and a right-handed cholesteric liquid crystal material.

133. The optical transmitter device according to Claim 130 wherein the cholesteric liquid crystal material for the second plurality of electrically switchable mirror elements has a constant pitch.

134. The optical transmitter device according to Claim 130 wherein the cholesteric liquid crystal material for the second plurality of electrically switchable mirror elements has a variable pitch.

135. The optical transmitter device according to Claim 126 wherein the at least one beam of light is linearly polarized.

136. The optical transmitter device according to Claim 126 wherein the at least one beam of light is circularly polarized.

137. The optical transmitter device according to Claim 126 wherein the at least one beam of light is randomly polarized.

138. The optical transmitter device in Claim 114 further comprising;

a second plurality of electrically switchable mirror elements for receiving light from the first plurality of electrically switchable mirror elements, the second plurality of electrically switchable mirror elements joining the first plurality of electrically switchable mirror elements at an angle;

wherein the optical transmitter device steers at least one beam of light in any polarization over 360° in azimuth and at least two angles in elevation.

139. The optical transmitter device in Claim 138 further comprising at least one receiver

140. The optical transmitter device according to Claim 139 wherein the at least one receiver is a focal plane array

141. The optical transmitter device according to Claim 140 wherein the focal plane array is a quadrant focal plane array

142. The optical transmitter device according to Claim 138 wherein the second plurality of electrically switchable mirror elements are made from cholesteric liquid crystal material.

143. The optical transmitter device according to Claim 142 wherein the second plurality of electrically switchable mirror elements further comprise a quarter wavelength retarder.

144. The optical transmitter device according to Claim 142 wherein the second plurality of electrically switchable mirror elements consist of a left-handed cholesteric liquid crystal material and a right-handed cholesteric liquid crystal material.

145. The optical transmitter device according to Claim 142 wherein the cholesteric liquid crystal material for the second plurality of electrically switchable mirror elements has a constant pitch.

146. The optical transmitter device according to Claim 142 wherein the cholesteric liquid crystal material for the second plurality of electrically switchable mirror elements has a variable pitch.

147. The optical transmitter device according to Claim 138 wherein the at least one beam of light is linearly polarized.

148. The optical transmitter device according to Claim 138 wherein the at least one beam of light is circularly polarized.

149. The optical transmitter device according to Claim 138 wherein the at least one beam of light is randomly polarized.

150. A free-space optical communication system, comprising;

at least two communication sub-systems, wherein each communication sub-system comprises;

at least one command system, wherein the at least one command system comprises a computer, software to run the communication system, electronics for the communication system, and cables connecting component parts of each subsystem; and

at least one wave guide beam steering device comprising a plurality of wave guide switching elements, comprising;

a wave guide substrate;

a plurality of planar wave guides attached to the wave guide substrate;

a plurality of liquid crystal materials attached to the wave guide substrate, the plurality of liquid crystal materials in operative optical contact with the plurality of planar wave guides, the plurality of liquid crystal materials having a first and second state, wherein the index of refraction of the plurality of liquid crystal materials in the first state matches the index of refraction of the plurality of planar wave guides, and wherein the index of refraction of the plurality of liquid crystal materials in the second state does not match the index of refraction of the plurality of planar wave guides;

a means for applying an electric field across the plurality of liquid crystal materials, wherein the plurality of liquid crystal materials switch between the first state and the second state as the electric field is applied;

a plurality of optical elements, the plurality of optical elements for coupling a beam of light of any polarization into and for receiving beam of light of any polarization reflected from each wave guide switching element of the wave guide beam steering device,

wherein a beam of light of any polarization state propagating in the wave guide is not reflected out of the wave guide beam steering device when the beam of light of any polarization state propagating in the wave guide reaches one of the plurality of liquid crystal materials in the first state, and wherein ~~whereby~~ the beam of light of any polarization state is reflected out of the wave guide beam steering device when one of the plurality of liquid crystal materials is in the second state;;

wherein the at least two communication sub-systems transmit and receive optical signals to and from each other.